REMARKS

The claims have been amended in order to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention. No substantive changes have been made to the claims and the claim language only has been changed in order to help the Examiner understand the presently claimed invention. No new matter has been added.

Claims 2-5, 11, 12, 15 and 16 have been rejected under the judicially created doctrine of obviousness-type double patenting over Claims 1-8 of U.S. Patent No. 6 086 766 in view of Smith et al. Claims 2, 5 and 11 have been rejected under 35 USC 103(a) as being unpatentable over Smith et al in view of JP 360118299 A (hereinafter referred to as JP '299). Claims 3 and 4 have been rejected under 35 USC 103(a) as being unpatentable over Smith et al in view of JP '299 and further in view of JP 404225900 A (hereinafter referred to as JP '900). Claim 12 has been rejected under 35 USC 103(a) as being unpatentable over Smith et al in view of JP '299 and further in view of Dorau et al. Claim 15 has been rejected under 35 USC 103(a) as being unpatentable over Smith et al in view of JP '299 and further in view of Lowther. Claim 16 has been rejected under 35 USC 103(a) as being unpatentable over Smith et al in view of JP '299 and Dorau et al and further in view of Lowther. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to a process for the aerobic biological treatment of an aqueous organic waste. This process comprises the steps of introducing the aqueous organic waste into an aeration tank, aerating the aqueous organic waste in the aeration tank in the presence of a biosludge comprising aerobic microorganisms to form an aerated aqueous suspension comprising excess sludge generated from the aqueous organic waste, withdrawing aerated aqueous suspension from the aeration tank and introducing the

withdrawn aerated aqueous suspension into a solid/liquid separation unit, subjecting the aerated aqueous suspension in the solid/liquid separation unit to solid/liquid separation to form a separated sludge and a separated liquid phase, withdrawing the separated liquid phase from the process as treated water, recycling at least a portion of the separated sludge back to the aeration tank, ozonizing either aerated aqueous suspension withdrawn from the aeration tank or a part of the separated sludge to ozonize and convert biosludge contained in the aerated aqueous suspension or part of the separated sludge into BOD components, the ozonizing taking place at a pH of no higher than 5, and recycling either the ozonized aerated aqueous suspension or the ozonized part of the separated sludge back to the aeration tank for aerobic biological treatment, wherein the amount of biosludge ozonized and converted into BOD components is greater than the amount of the excess sludge generated in the aeration tank.

In a second embodiment of the present invention, the aerated aqueous suspension is introduced into a membrane separation unit to form a permeated liquid and a concentrated sludge and the biosludge contained in the aerated aqueous suspension or part of the concentrated sludge converted into BOD components, with the remaining steps being the same as the embodiment discussed above.

There are two critical features of the present invention. The first feature is that the biosludge contained in the aerated aqueous suspension or sludge separated by the solid/liquid separation step is ozonized at a pH of 5 or lower. The second critical feature of the present invention is that the amount of biosludge ozonized and converted into BOD components is greater than the amount of excess sludge generated in the aeration tank. With respect to the ozonizing taking place at a pH of no greater than 5, as discussed in the present specification, biosludge is made of slime materials and cell walls mainly consisting of polysaccharides and cytoplasms composed mainly of proteins. When this biosludge

is subjected to an ozone treatment, the polysaccharides oxidatively decompose into BOD components so that the cells are destroyed and the proteins flow out and react with the ozone. As the proteins react with the ozone, the proportion of the ozone that reacts with the polysaccharides correspondingly decreases. If the ozone treatment is carried out at a pH of not higher than 5, a reaction of the ozone with the proteins is retarded due to the possible coagulation of the proteins in the acidic medium. As such, the proportion of the reaction of the ozone with the polysaccharides increases with the result that more polysaccharides are oxidatively decomposed at a lower ozone dose.

The feature of the invention requiring the ozone treatment to be carried out at a pH of not higher than 5 would not have been arrived at by one of ordinary skill in the art simply by the fact that the stability of ozone is increased at a lower pH value. Since it is necessary for the ozone to decompose in order to react with the polysaccharides during the ozone treatment, one of ordinary skill in the art would come to the conclusion that the more stable the ozone, the lower the reaction rate. Additionally, there is no reason to imagine that the retardation of the protein-ozone reaction due to protein coagulation for the mechanism of increasing the efficiency of biosludge reduction. It could be assumed that the ozonization efficiency would decrease due to possible acceleration of the decomposition of the protein. Therefore, Applicants respectfully submit that this aspect of the present invention is unobvious in view of the prior art cited by the Examiner.

The second aspect of the present invention requires that the amount of biosludge ozonized and converted into BOD components is greater than the amount of the excess sludge generated from the aqueous organic waste. The present invention provides a new approach for the biological treatment of an aqueous organic waste by ozonizing a greater amount of biosludge than the excess sludge generated in the aeration

tank. The biosludge formed during anaerobic biological treatment, activated sludge, is composed mostly of living microbes and is hardly destroyed during a biological treatment such that only a quite limited reduction of the amount of the activated sludge formed during biotreatment is achieved by biological treatment only. In the present invention, an amount of activated sludge existing in the aerobic biotreatment system, which is greater than the amount of excess sludge generated by the decomposition of the aqueous organic waste, is withdrawn therefrom and subjected to an ozone treatment to convert the living microbes therein into biodegradable organic matter by destroying them. Since the ozone treatment results in the generation of an additional organic sludge, the present inventors realized that in order to reduce the presence of excess sludge in the system, it is necessary to ozonize an amount of organic sludge that is greater than the aqueous organic sludge generated during the decomposition of the aqueous organic waste in the aeration tank. The prior art does not speak to this feature.

When ozone treatment is incorporated into the aerobic biotreatment directly, the living microbes acting to metabolize organic matter in the waste liquor are destroyed by the ozonization and do not participate further in the biological treatment of the waste liquor. The present invention reduces the amount of activated sludge during the aerobic biological treatment of the aqueous organic waste by withdrawing the above-discussed amount of activated sludge and subjecting it to an ozone treatment so that the ozonized sludge is recycled back to the aerobic biological treatment system.

When ozone is introduced into the aerobic biotreatment system directly in such a small amount that the living microbes in the biotreatment system do not become extinct, a decrease in the amount of the activated sludge is not realized since any destruction of the living cells of the microbes would not occur. Therefore, in order to obtain a reduction in

the amount of activated sludge in the system, it is important that the biosludge is ozonized in such a manner that the steady state of biological treatment in the biotreatment system is not disturbed. Therefore, a reduction of the amount of activated sludge can only be attained by withdrawing such an amount of biosludge from the biotreatment system and subjecting the withdrawn sludge to an ozone treatment and recycling the so-ozonized biosludge back to the biotreatment system. The present invention is based on the discovery that it is necessary that the amount of biosludge withdrawn from the biotreatment system be greater than that formed during the aerobic biotreatment since an additional amount of activated sludge is formed by proliferation of the microbes in the biosludge by metabolizing the organic matter originating from the ozonized biosludge. When the ozonization of the biosludge is effected at a pH of no greater than 5, the biosludge can be converted into biodegradable organic matter with a smaller amount of ozone. According to the present invention, by effecting the ozone treatment of the excess sludge at a pH of no greater than 5, an amount of about from 1/2 to 1/3 is needed as compared to the prior art techniques without pH control. It is respectfully submitted that the prior art cited by the Examiner does not disclose the presently claimed invention.

U.S. Patent No. 6 086 766 to Yasui discloses a process for reducing the amount of excess sludge by aerobically treating an aqueous organic waste in an aeration tank in the presence of a biosludge containing aerobic microorganisms, subjecting the resulting mixed liquor to a solid/liquid separation, the separated liquid phase being discharged as treated liquor, and supplying at least a part of the separated biosludge, after having been treated with ozone, to the aeration tank. The ozone treatment is accomplished by passing a mixed flow of a biosludge-containing liquor to be treated or a liquor containing the ozonized biosludge and of an ozone-containing gas through a flow-down pipe in a downward flow and

introducing the flow into an ozone-treating vessel in the state in which the ozone-containing gas gets dispersed as finely disintegrated bubbles to avoid the clogging of a gas diffuser due to the adhesion of the biosludge and contains ozone treatment at a high ozone yield. The claims of this patent have no disclosure with respect to the amount of biosludge being ozonized and converted into BOD components being greater than the amount of generated excess sludge. As discussed above, this enables the system to be operated in a manner such that the amount of generated excess sludge formed in the entire system can be reduced to zero. The Smith et al reference must contain a teaching or suggestion that such a result can be accomplished. It is respectfully submitted that the Smith reference contains no such teaching or suggestion.

The Smith reference discloses a method of treating sewage or other biodegradable waste materials in a system including an aerobic process wherein a settleable sludge is formed which comprises returning a part or all of the sludge to a point in advance of the input of the aerobic process and subjecting a selected portion of the returned sludge to the action of ultraviolet or other bactericidal rays for the biolysis of the bacteria in said portion. A portion of the returned sludge is selected to meet the food requirements of the active aerobic bacteria in the aerobic process. The portion subjected to biolysis is so regulated that substantially all of the biodegradable matter is consumed and only a relatively small quantity of sludge is removed to end disposal.

Smith discloses, in column 1, lines 59-67, that process control problems are due to the necessity of producing a constant process efficiency from the numerous variables present in the inflow, such as volume, strength, etc. The inventory of biological population must be necessary to be sufficient for maximum loading conditions when these conditions occur. On the other hand, for the balance of the time, an "underloaded condition" exists which adversely affects process values, efficiency and control.

The system in the Smith reference works on the basis of artificially maintaining a correct ratio of food to organisms as a steady state condition. The protozoa readily assimilate the dead bacterial masses resulting from the biolysis and by means of their oxidative metabolic processes continuously convert the food to carbon dioxide and water. To achieve this end, this reference provides a microbial biolysis unit consisting of a source of radiant energy in which a controlled portion of the sludge, after biolysis, is returned to the system. This means that in the Smith method, controlled biolysis of the excess sludge is effected in the "underloaded condition" and excess sludge forming condition in order to control the ratio between these portions so as to maintain a predetermined balance between the biodegradable organic matter, which constitutes food for the process, and the active organisms in the aerobic treatment step such that the inactivated organisms returned to the treatment step after biolysis are substantially consumed by the active organisms with a corresponding reduction in sludge content. Biolysis of the excess sludge is stopped in the "overloaded condition" because further biolysis of the excess sludge would cause an irregular balance between the biodegradable organic matter and the active organisms. Therefore, in the method disclosed in Smith, controlled biolysis of excess sludge is performed only in the "underloaded condition" and the biolysis is performed on the excess sludge which has already been generated.

In the aerobic biological treatment system 1 in Fig. 1 of the present invention, a certain amount of a biosludge 3a is maintained for realizing an aerobic treatment of the waste. When an aerobic biological treatment is effected by supplying the system 1 with the aqueous waste 4 to be treated, the BOD components contained in the aqueous waste 4 is anabolized in the biosludge 3a and a newly grown biosludge 3b is formed by the decomposition of the aqueous waste 4. On the other hand, the biosludge 3a present in the system 1 is subjected to an autolysis and loses an autolysis decrement 3c. Therefore, in

the steady state, the difference between the grown biosludge 3b and the autolysis decrement 3c remains as the multiplication increment 3d, which is the generated excess sludge.

In convention techniques of biosludge reduction, this multiplication increment 3d is taken out of the system to reach the reduction of the biosludge amount, so that 50% of this increment is disposed as the digested sludge. In Smith, the multiplicated sludge 3d exhausted as excess sludge is subjected to biolysis in the "underloaded condition", whereupon the resulting mass is returned to the aerobic biological treatment system 1. By this technique, however, a further newly grown biosludge is formed by the additional BOD from the hydrolysis, resulting in an occurrence of excess sludge after the treatment.

In Fig. 1, by returning the multiplicated sludge 3d to the aerobic biological treatment system 1, after it has been ozonized, the BOD portion formed by the ozone treatment will be converted into an additional amount of biosludge 3e as a substantial multiplication increment of biosludge which has to be exhausted as excess sludge. Thus, the biosludge reduction rate in the case where the multiplicated sludge 3d is returned to the aerobic biological treatment system after it has been ozonized may amount to 30-40%, based on the weight of the multiplicated biosludge increment 3d, which is lower than that reached in conventional anaerobic or aerobic digestion.

If, in contrast a greater amount of biosludge 3f than that of the multiplicated biosludge 3d is extracted from the aerobic biological treatment system 1 and is subjected to an ozone treatment in the ozone treatment system 2 to convert it into BOD components, before it is returned to the aerobic biological treatment system 1 as an ozonized biosludge 6, a further grown biosludge 3g will be formed from the portion of BOD produced by the ozone-decomposition. Here, the difference between the extracted amount of biosludge 3f and the formed

amount of biosludge 3g corresponds to the mineralized amount 3h.

When a greater amount of biosludge 3f than the multiplicated amount 3d is extracted and subjected to an ozone treatment to convert it into BOD components, the proportion of the mineralization will be greater than the case where only the multiplicated amount 3d is subjected to ozone treatment, whereby the biosludge reduction rate is increased. By adjusting the amount of the extracted biosludge 3f in such a manner that the amount of the multiplicated biosludge 3d is equal to the amount of mineralization 3h, the amount of excess biosludge will reach substantially zero. If the amount of multiplicated biosludge 3d is greater than the amount of mineralization 3h, the difference between them corresponds to the amount of substantial increment 3i which is exhausted out of the system as excess sludge 7.

Applicants also wish to point out that the Smith reference has no disclosure with respect to the advantages of ozonizing the biosludge at a pH of not greater than 5. Therefore, the secondary references cited by the Examiner must provide the motivation to one of ordinary skill in the art to modify the Smith reference in a manner such that the claimed method is obtained. It is respectfully submitted that the secondary references cited by the Examiner contain no such motivation.

JP 36—118299A discloses a method for modifying and dehydrating organic sludge in which the pH of sludge supplied from a sludge tank is adjusted to from 3-6 and then mixed and contacted with an ozone-containing gas to perform modification thereof. The modified sludge is dehydrated and discharged as a dehydrated cake. However, this reference has no disclosure with respect to performing a process for biological treatment of aqueous organic waste using an ozonization step in which the amount of biosludge ozonized and converted into BOD components is greater than the amount of excess sludge generated or the advantages associated with the ozonization

step taking place at a pH no greater than 5. Therefore, it is respectfully submitted that the presently claimed invention is patentably distinguishable over Smith et al in combination with JP 36-0118299A.

JP 40-4225900A discloses a method for anaerobically digesting organic sludge in which an organic sludge is heated in a sludge heating tank, introduced into a flotation concentration tank and then introduced into an anaerobic digestion tank. However, this reference does not cure the deficiencies of the previously discussed references in that it does not disclose the performing of an ozonization step in which the amount of biosludge ozonized and converted into BOD components is greater than the amount of excess sludge generated or the advantages associated with the ozonization step taking place at a pH no greater than 5 or suggest anything regarding the benefits achieved by such an operation. As such, it is respectfully submitted that the presently claimed invention is patentably distinguishable over this reference in combination with any of the previously discussed references.

The Dorau et al reference discloses a method and apparatus for biologically purifying sewage which is organically loaded with substances which are difficult to decompose biologically or not decomposable biologically. This reference further discloses the use of membrane-filtering or nano-filtering to remove substances that are difficult to decompose biologically or not biologically decomposable. However, this reference does not cure the deficiencies of the previously discussed references in that it does not suggest operating a process for biological treatment of aqueous organic waste utilizing an ozonization step in which the amount of biosludge ozonized and converted into BOD components is greater than the amount of excess sludge generated or the advantages associated with the ozonization step taking place at a pH no greater than 5. As such, the presently claimed

invention is patentably distinguishable over this reference in combination with any of the previously discussed references.

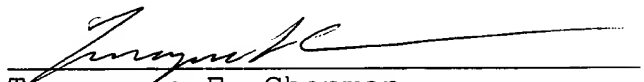
The Lowther reference discloses a process for the intermediate treatment of aqueous sewage containing biodegradable materials and non-biodegradable materials. The sewage is contacted with an organic-containing gas to pretreat the sewage by converting a substantial amount of the non-biodegradable material to biodegradable material, followed by a conventional secondary treatment with an oxygen-containing gas such as air in the presence of aerobic or facultative anaerobic microorganisms. This process may also include subsequent tertiary treatment with ozone to destroy the microorganisms after secondary treatment. However, this reference does not disclose the performing of an ozonization step under such conditions such that the amount of biosludge ozonized and converted into BOD components is greater than the amount of generated excess sludge or the advantages associated with the ozonization step taking place at a pH no greater than 5. Therefore, Applicants respectfully submit that the currently claimed invention is patentably distinguishable over this reference in combination with any of the previously discussed references.

None of the references cited by the Examiner disclose performing an ozonization step in which the amount of biosludge ozonized and converted into BOD components is greater than the amount of generated excess sludge or the advantages associated with the ozonization step taking place at a pH no greater than 5. As stated previously, in the present invention, the amount of excess sludge which has to be removed and disposed of can be eliminated by ozonizing and converting to BOD components an amount of biosludge which is greater than the amount of excess sludge generated and an unexpected high efficiency is achieved by conducting the ozonization at a pH no greater than 5. None of the references cited by the Examiner disclose these features and, as such, it is respectfully submitted that the presently claimed invention

is clearly patentably distinguishable over the prior art cited by the Examiner.

Reconsideration of the present application and the passing of it to issue is respectfully solicited.

Respectfully submitted,



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